

## **Chapter 6**

### **Certification Methods for Transfer Standards**



**Chapter 6**  
**Certification Methods for Transfer Standards**  
**Table of Contents**

	<b>Page</b>
<b>1.0 Introduction.....</b>	<b>1</b>
1.1 Scope.....	1
1.2 Definition.....	1
1.3 Applicability.....	1
<b>2.0 General Use of Transfer Standards.....</b>	<b>1</b>
<b>3.0 Transfer Analyzer Calibration.....</b>	<b>2</b>
<b>4.0 Certification of Transfer Standards.....</b>	<b>4</b>
4.1 Introduction.....	4
4.2 Permeation Transfer Standards.....	4
4.3 Dilution Systems using Gas Cylinder Standards.....	5
4.4 Direct Gas Cylinder Standards.....	5
4.5 Certification Limits.....	6
<b>5.0 Certification of Ozone Transfer Standards.....</b>	<b>6</b>
5.1 Introduction.....	6
5.2 Primary Standard.....	7
5.3 Ozone Generators.....	7
5.4 Ozone Photometers.....	7
5.5 Standard Ozone Concentration Calculation.....	8
5.6 Certification Limits.....	8
<b>6.0 Calibration of Orifice Flow Rate Transfer Standards.....</b>	<b>9</b>
6.1 Introduction.....	9
6.2 Calibration Requirements.....	9
6.2.1 Hansen Orifice.....	9
6.2.2 Variable Orifice.....	9
<b>7.0 Calibration of Flow Transfer Standard for PM<sub>2.5</sub> Samplers.....</b>	<b>10</b>
<b>8.0 Mass Flow Meters.....</b>	<b>10</b>
<b>9.0 Thermometers.....</b>	<b>11</b>
<b>10.0 Multimeters.....</b>	<b>11</b>
<b>11.0 Relative Humidity.....</b>	<b>12</b>
<b>12.0 BIOS and other Flow Systems.....</b>	<b>12</b>

<b>13.0 Class “S” Weights.....</b>	<b>12</b>
------------------------------------	-----------

## **14.0 Certifications/Calibrations/Verifications of Miscellaneous**

<b>Transfer Standards.....</b>	<b>13</b>
14.1 Introduction.....	13
14.1.1 Elapsed Time Meters.....	14
14.1.2 Barometers.....	14
14.1.3 Wind Speed Calibrators/Selectable Speed Anemometer Drives.....	14
14.1.4 Strip Chart Recorders.....	14
14.1.5 Pyranometer/Radiation Sensors.....	14
14.1.6 Power Supply.....	14
14.1.7 Stop Watches.....	14
14.1.8 Rotameters.....	14
14.1.9 Electronic Manometers.....	15
14.1.10 Photo Tachometers.....	15

## **TABLES**

<b>1. Recommended Multipoint Calibration Concentrations.....</b>	<b>2</b>
<b>2. Thermometer Certification Ranges.....</b>	<b>11</b>
<b>3. Multimeter Certification Limits.....</b>	<b>12</b>
<b>4. Class 2 Metric Weight Tolerances.....</b>	<b>13</b>
<b>5. Certification/Calibration/Verification of Miscellaneous Transfer Standards.....</b>	<b>15</b>

## **FORMS**

<b>1. SO<sub>2</sub> Calibration with Permeation Tube.....</b>	<b>16</b>
<b>2. Ozone Transfer Standard Certification.....</b>	<b>17</b>
<b>3. Hi-Vol Orifice Calibration.....</b>	<b>18</b>

## **1.0 Introduction**

### **1.1 Scope**

This chapter presents the requirements for the use of air monitoring transfer standards in the state of Indiana. These requirements are general in nature. Information concerning specific instrumentation should be obtained from the manufacturer.

### **1.2 Definition**

A transfer standard is defined as a transportable device or apparatus which, together with associated operational procedures, is capable of accurately reproducing standard values (e.g., pollutant concentrations, flows) or producing accurate assays of these standard values which are quantitatively related to an authoritative primary standard.

### **1.3 Applicability**

The requirements of this chapter apply to those organizations (state, local, industrial, and consulting) that use transfer standards in the state of Indiana.

## **2.0 General Use of Transfer Standards**

All transfer standards used in Indiana are subject to Indiana Department of Environmental Management (IDEM), Office of Air Quality (OAQ), Quality Assurance Section (QAS) requirements. All transfer standards used in the state of Indiana must be certified directly traceable to the primary standards maintained at the IDEM, OAQ, QAS Certification Facility. Primary standards provide a standard reference throughout the State and supersede all other standards except for standards maintained at the National Institute of Standards and Technology (NIST). The QA primary standards are either NIST Standard Reference Material (SRM), U.S. EPA/NIST-approved NIST Traceable Reference Material (NTRM), or Gas Manufacturer's Intermediate Standards (GMIS).

With State Quality Assurance Section approval, agencies, consultants, or industries using multiple audit calibrators may have one transfer standard (master calibrator) certified by QA and use it to certify their calibrators. These units are then referred to as calibration standards. As in all field work, error can be increased through the use of multiple calibration systems. If the master calibrator agrees with the primary standard within  $\pm 2.0\%$ , and is used to certify a transfer standard within  $\pm 3.0\%$ , and then the transfer standard is used to calibrate a monitor to within  $\pm 2.0\%$ , the possibility exists for an error of  $\pm 7.0\%$ . For this reason, care must be taken to reduce error as much as possible.

Transfer standard calibrators and cylinders ( $\text{CO}$ ,  $\text{SO}_2$ ,  $\text{NO}$ ) must be certified once every 6 months except for direct  $\text{CO}$  cylinders which must be certified every 24 months. Transfer standard analyzers should be calibrated quarterly; however, the state QA may allow a longer time period if the instrument shows good repeatability and accuracy. Ozone transfer standards must be certified twice per quarter (approximately) every 3 months. Major maintenance or any

modification affecting the output of the calibrator (such as change of cylinder or permeation tube) necessitates recertification. Check individual sections of this chapter for specifics and exceptions. A copy of all certifications must be filed with the IDEM, OAQ, Quality Assurance Section. Failure to comply with these requirements may result in invalid data and/or enforcement action.

### 3.0 Transfer Analyzer Calibration

Transfer standard certifications are performed using analyzers designated by U.S. EPA as reference method or equivalent method. Room temperature during calibrations/certifications must be  $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ . Connecting tubing and manifolds must be constructed of either borosilicate glass or TFE Teflon. The analyzer's calibration curve must be verified at approximately 85 and 50 percent of full scale using a primary standard (or master calibrator) prior to being used for certifications. A new multipoint calibration must be run if either of the two verification points deviates from the calibration curve more than 2% or if the transfer analyzer has not been calibrated within the last 6 months. Multi-point calibrations consist of three or more test concentrations, including zero concentration, a concentration between 80% and 90% of the full scale range of the analyzer under calibration, and one or more intermediate concentrations spaced approximately equally over the scale range.

**Table 1**  
**Recommended Multipoint Calibration Concentrations**

Range in ppm	Calibration Concentrations in ppm
0.5 (O <sub>3</sub> , SO <sub>2</sub> , NO <sub>2</sub> )	(1) .40 to .45 (2) .18 to .22 (3) 0
1.0 (SO <sub>2</sub> )	(1) .85 to .90 (2) .40 to .45 (3) 0
50 (CO)	(1) 40 to 45 (2) 18 to 22 (3) 0

Concentrations generated by the primary standard or master calibrator permeation systems are determined using Equation 6-1 or 6-2 (see Form 1).

#### Equation 6-1

$$C \text{ ppm} = \frac{(\text{Pr}) \times (\text{G})}{(\text{M}) \times (\text{F}_t)}$$

Where:

C ppm	=	Concentration, ppm
Pr	=	Permeation Rate, $\mu\text{g}/\text{min}$
G	=	Gas Constant (24.46), volume of 1 mole of gas at Standard Reference Conditions (SRC, $25^{\circ}\text{C}$ and 760 mmHg) ( $\mu\text{L}/\mu \text{ mole}$ )
M	=	Molecular Weight of permeated molecule ( $\mu\text{g}/\mu \text{ mole}$ )
F <sub>t</sub>	=	Total flow, L/min at SRC

### Equation 6-2

$$C_{\text{ppm}} = \frac{(\text{Pr}) \times 0.382 (\text{SO}_2)}{F_t}$$

Where:

$C_{\text{ppm}}$  = Concentration, ppm (equal to  $\mu\text{L/L}$  on right side of Equation)  
 $\text{Pr}$  = Permeation Rate,  $\mu\text{g/min}$   
 $F_t$  = Total flow, L/min at SRC

Concentrations generated by the primary standard or master calibrator gas dilution system are determined using Equation 6-3.

### Equation 6-3

$$C_{\text{ppm}} = \frac{\text{GF} \times \text{CC}}{\text{GF} + \text{DF}}$$

Where:

$C_{\text{ppm}}$  = Concentration, ppm  
 $\text{GF}$  = Gas flow, cc/min  
 $\text{CC}$  = Cylinder Concentration, ppm  
 $\text{DF}$  = Dilution flow, cc/min

The concentration generated by the primary standard direct cylinder is determined using Equation 6-4.

### Equation 6-4

$$C_{\text{ppm}} = \text{NIST value}$$

Where:

$C_{\text{ppm}}$  = Concentration, ppm

The slope, intercept, and correlation coefficient for the calibration is computed by the least-squares linear regression of the standard concentration (y) and the analyzer response (x). The transfer analyzer calibration must meet the following criteria in order to be acceptable (See Form 1):

1. All calibration points must fall within  $\pm 3.0\%$  of the line of best fit. This is determined using Equation 6-5:

### Equation 6-5

$$\frac{\text{Measured Concentration} - \text{Standard Concentration}}{\text{Standard Concentration}} \times 100$$

2. The difference between the highest and lowest percentages must be less than or equal to 4.0%.
3. The correlation coefficient must be at least 0.999.

The calibration must be repeated if it does not meet the above criteria. Failure to meet the above criteria after several calibration attempts may indicate a problem with the analyzer. At that time, the analyzer should be considered suspect and not used to perform certifications.

## 4.0 Certification of Transfer Standards

### 4.1 Introduction

Concentrations are generated by the transfer standard and introduced to the transfer analyzer which has been calibrated using either a NIST-SRM, U.S. EPA/NIST-approved NTRM, or GMIS.

### 4.2 Permeation Transfer Standards

Permeation transfer standards must be stable prior to certification. Stability is defined as: the permeation device must be equilibrated at the system's operating temperature for a period of not less than 24 hours upon initial installation; or 4 hours if the system had been operating previously. The temperature should be verified by comparison with a NIST-traceable thermometer prior to certification to ensure that the system is operating within the required temperature range and the temperature is stable. The temperature of the permeation oven affects the permeation rate so higher operational temperatures may require longer stabilization times.

Four certification concentrations and a zero must be introduced into the transfer analyzer. The certification concentrations should be evenly spaced (e.g., .800, .400, .200, .100, and 0 ppm) and fall within the calibration curve of the transfer analyzer. Three certification concentrations per permeation device are acceptable for systems which utilize two separate permeation devices.

The permeation rate ( $\mu\text{g}/\text{min}$ ) for each certification concentration is calculated using Equation 6-6.

#### Equation 6-6

$$\text{Permeation Rate } (\mu\text{g}/\text{min}) = \frac{\text{MC} \times F_t}{0.382 (\text{SO}_2)}$$

Where:

MC	=	Measured Concentration, ppm
Measured Concentration	=	(monitor response x slope) + intercept
$F_t$	=	Total flow, L/min at SRC

### 4.3 Dilution Systems Using Gas Cylinder Standards

The gas dilution system certification usually includes the blending system, cylinder, regulator, sample delivery lines, and clean air system. If the system has mass flow meters, the meter display must be certified to a NIST-traceable flow standard (see Section 8.0). If the system does not have mass flow meters, flow rates should be measured at each certification concentration using an NIST-traceable flow standard.

Normally four certification concentrations and a zero are introduced into the transfer analyzer. The certification concentrations should be evenly spaced and fall within the calibration curve of the transfer analyzer (e.g., .800, .400, .200, .100, and 0 ppm).

An average cylinder concentration is determined from the mean of the calculated concentrations using Equation 6-7.

#### Equation 6-7

$$\text{Calculated Cylinder Concentration (ppm)} = \frac{\text{Measured Concentration (ppm)} \times \text{Total Flow (cc/min)}}{\text{Cylinder Flow (cc/min)}}$$

Where:

$$\begin{aligned} \text{Measured Concentration} &= (\text{monitor response} \times \text{slope}) + \text{intercept} \\ \text{Total Flow} &= \text{cylinder flow} + \text{dilution flow in cc/min at SRC} \end{aligned}$$

### 4.4 Direct Gas Cylinder Standards

Cylinder gas not requiring dilution is introduced into the analyzer at ambient pressure using a manifold or a tee delivery line. Flow to the manifold or tee delivery line should exceed the transfer analyzer's flow demand by at least 25 percent. A certified rotameter is recommended to control the amount of flow.

Cylinder gas must be introduced into the analyzer at least two times per cylinder with either zero air or a cylinder gas with a different concentration introduced between each certification point. Zero air should be introduced to the transfer analyzer a minimum of once per every six cylinders.

An average cylinder concentration is determined from the mean of the two calculated concentrations using Equations 6-8 and 6-9.

#### Equation 6-8

$$\text{Calculated Cylinder Concentration (ccc)} = (\text{monitor response} \times \text{slope}) + \text{intercept}$$

### Equation 6-9

$$\text{Average Cylinder Concentration} = \frac{\text{ccc} + \text{ccc}}{2}$$

## 4.5 Certification Limits

In order for a certification to be considered valid, it must meet the limits listed below. If not, the cylinder or permeation tube should not be used or it may be run on another day to determine if the average concentration is repeatable. If it is repeatable, the average concentration may be used for audits/calibrations. However, care must be taken to ensure that when audits or calibrations are performed with the new cylinder or permeation value that no major changes occur which would question the integrity of the certification.

1. All calculated concentrations must be within  $\pm 4.0\%$  of the average concentration.
2. The difference between any two calculated concentrations must be less than or equal to  $5.0\%$ .
3. The average concentration should be within  $\pm 4.0\%$  of the previously established average concentration.

## 5.0 Certification of Ozone Transfer Standards

### 5.1 Introduction

Ozone transfer standards are certified in accordance with 40 CFR Part 50, Appendix D. A quantitative relationship is established for each transfer standard consisting of the average of six individual comparisons of the transfer standard with a primary ozone standard. Each comparison must be performed on a different day within a two week period for the comparisons. For each certification, the following general procedures must be used:

1. Six (6) concentrations including a zero are generated by an ozone generator and introduced into the primary ozone standard and, if applicable, the transfer standard. Concentrations are corrected for a zero offset with primary standard concentrations, also corrected for the amount of ozone lost (see Section 5.2). The slope and intercept for this comparison are computed using the least-squares linear regression of the transfer standard display or output (y), and the primary standard display (x).
2. Compute the average slope, intercept, relative standard deviation of the slopes, and the relative standard deviation of the intercepts for the six comparisons. Certifications must meet the limits specified in Section 5.6.
3. One-day recertification as required by the following paragraph consists of performing a one day comparison to generate a new six-day slope and intercept. The six most recent

comparisons must be used to calculate the new average slope and intercept as well as the new relative standard deviation of the slopes and the intercepts. Certifications must meet the limits specified in section 5.6 (see Form 2).

Ozone transfer standards must be recertified every three months.

## **5.2 Primary Standard**

The primary standard for ozone in Indiana is an ultraviolet (UV) photometer. This instrument is dedicated exclusively to certification service to ensure the accuracy of the instrument by minimizing its exposure to potential damage during transport. The primary standard is certified annually by verification against the NIST Standard Reference Photometer at U.S. EPA Region V.

An ozone loss test is performed on the primary standard annually prior to verification at U.S. EPA Region V headquarters to quantify the amount of ozone lost due to leaks or contact with the photometer cell walls and gas handling components. Measurements are corrected for ozone loss. The ozone loss must not exceed five (5.0) percent. Ozone loss test procedures are provided in U.S. EPA Technical Assistance Document, "Technical Assistance Document for the Calibration of Ambient Ozone Monitors, September 1979".

## **5.3 Ozone Generators**

Ozone generators are certified by comparing their output concentration against the primary standard display. Ozone generators should be allowed to warm up for approximately one hour prior to certification. Normal operating temperature is usually indicated by a heater lamp becoming lit. For each certification, six concentrations are generated by the ozone generator and introduced into the primary standard. The generator must provide at least 25% more flow than demanded by the primary standard. The generator output is introduced into the sample inlet of the primary standard. The clean air supply used by the generator must also be used to supply zero reference air to the zero air inlet of the primary standard at ambient pressure. The same clean air supply used for field use should be used for the certification.

Measurements are corrected in the following ways:

1. The primary standard internally compensates readings to SRC.
2. The zero offset must be subtracted out.
3. Primary standard display readings are mathematically corrected to account for ozone loss.

## **5.4 Ozone Photometers**

Ozone photometers are certified by comparing their display readings against the primary standard display. For each certification, six concentrations are generated by an ozone generator

and introduced into both the transfer standard photometer and primary standard photometer. The generator must provide at least 25% more flow than demanded by both photometers. The same clean air supply must be used to supply zero reference air to the zero air inlet of both photometers. If possible, the same clean air supply used for field use should be used for the certification.

Measurements are corrected in the following ways:

1. The primary standard internally compensates readings to SRC.
2. The zero offset must be subtracted out.
3. Transfer standard photometers must be manually adjusted to correct readings to standard temperature and pressure if they do not internally compensate readings.
4. Primary standard display readings are mathematically corrected to account for ozone loss.

### 5.5 Standard Ozone Concentration Calculation

The transfer standard ozone concentration is calculated using Equation 6-10.

#### Equation 6-10

$$\text{Standard Ozone Concentration} = \frac{\text{indicated concentration} - \text{intercept}}{\text{slope}}$$

Where:

indicated concentration = display for photometers (minus the zero offset) or  
6 day average for generators

### 5.6 Certification Limits

The results of the certification are acceptable when the following criteria are met:

1. The current slope is within  $\pm 5.0\%$  of the previously established average slope.
2. The standard deviation of the slopes is  $\leq 3.7\%$ .
3. The standard deviation of the intercepts is  $\leq 1.5\%$ .

A new six-day certification will be required if the above certification limits are not met. In addition, a six-day certification will be required if the ozone transfer standard goes more than twice per quarter (approximately every 3 months) without a certification.

## **6.0 Calibration of Orifice Flow Rate Transfer Standards**

### **6.1 Introduction**

Transfer standard orifices (e.g., Hansen or variable) are calibrated by comparing the transfer standard orifice to a positive displacement standard volume meter (Roots Meter) which must be NIST-traceable. Specific orifice calibration procedures are listed in "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Specific Methods (EPA/600/4-77/027a), Section 2.2.2.5".

### **6.2 Calibration Requirements**

Transfer standard orifices must be calibrated against a positive displacement standard volume meter annually. If an orifice is damaged or a part is replaced that affects the flow, the orifice must be calibrated prior to use (see Form 3).

The following criteria must be met in order for the calibration to be valid (see Form 3):

1. A minimum of five (5) calibration flows must be run.
2. All calibration points must be in the range of 1.0 to 1.8 cubic meters per minute. At least three of these points must be in the flow rate interval of 1.02 to 1.24 cubic meters per minute and at least three of the points must be from 1.1 to 1.7 cubic meters per minute.
3. All calibration points must fall within  $\pm 1.0\%$  of the calibration curve.
4. The calibration should be within  $\pm 2.0\%$  of the previous calibration. Comparing at least two reference points (e.g.,  $1.13 \text{ m}^3/\text{min}$  and  $1.30 \text{ m}^3/\text{min}$ ) on the current calibration to the previous calibration should determine if the curve has shifted more than the  $\pm 2.0\%$ .

#### **6.2.1 Hansen Orifice**

When calibrating a Hansen orifice, vary the flow rate by using different resistance plates or use a 13 hole plate and a voltage varying device (e.g., Variac). An electronic manometer is used to measure the pressure drop across the orifice during the calibration. A electronic manometer is used to measure the standard volume meter inlet pressure drop. The manometer used on the orifice must contain the same fluid as used for field measurements (e.g., water, water and ethylene glycol mixture). Five calibration points must be run between 1.0 and 1.8 cubic meters per minute.

#### **6.2.2 Variable Orifice**

Variable orifices are calibrated in the same manner as a Hansen orifice except for the following differences. When calibrating a variable orifice, do not use a resistance plate. Place the orifice on a base plate and open the orifice all the way. Attach a filter cone to the roots meter. Secure the base plate with the orifice on it onto a filter cone with a quartz filter in line. Secure with

wing nuts. The flow rate can be varied by using a voltage varying device (e.g., Variac) or by opening and closing the variable orifice.

## 7.0 Calibration of Flow Transfer Standard for PM<sub>2.5</sub> Samplers

Flow transfer standards (FTS), i.e. pressure drop-type, are required to be calibrated/recertified annually. Currently these devices are returned to the manufacturer for calibration. An “in-house” calibration procedure is under development by the State QAS Certification Facility.

## 8.0 Mass Flow Meters

Mass flow meters are certified every six (6) months by comparison with a NIST-traceable primary standard Cal Technix, Molbox1-A, SN 378, Flow System using a certified flow meter. This flow system uses laminar flow theory and known thermodynamic properties of gases in determining the flows. For each calibration, at least four (4) calibration flows are measured. The slope and intercept for this comparison is computed using the least-squares linear regression of the transfer standard display (x) and the standard flow rate (y). Agencies may certify mass flow meters by use of a BIOS flow calibrator, which has been verified/certified with the State-QA primary Cal Technix. Also, a Hastings bubble kit, which includes an NIST-traceable volume and certified time piece, may be used. Using the Hastings bubble kit, mass flow rates must be calculated using Equations 6-11 and 6-12. Equation 6-11 is used to convert measured flow rates at actual conditions to measured flow rates at standard reference conditions. Equation 6-12 is used to calculate the measured flow rate by using the mass flow meter display value.

### Equation 6-11

$$\text{Standard Flow} = \text{Flow Rate} \times \frac{(\text{BP} - \text{VP}) \times 298 \text{ K}}{(T \times 760 \text{ mmHg})}$$

Where:

BP	=	Station barometric pressure in millimeters of mercury. The station is the location where measurements are being taken.
VP	=	Vapor pressure in millimeters of mercury
T	=	Ambient station temperature in Kelvin

### Equation 6-12

$$\text{Measured Flow Rate} = (\text{meter display} \times \text{slope}) + \text{intercept}$$

Mass flow meter certifications must meet the following requirements:

1. The difference between the curve flows and the true flows must be within  $\pm 2.0\%$ .
2. If not, the certification must be repeated. If all of the flows still do not meet this requirement, the flow controller should be considered suspect and corrective action should be taken.

3. If one flow is not within  $\pm 2.0\%$  and all of the other flows meet these criteria, a direct flow reading can be measured and corrected to standard reference conditions. However, this flow should not be used in calculating the calibration curve.

## 9.0 Thermometers

Thermometers must be certified traceable to the OAQ/QAS Certification Facility's NIST-traceable thermometer. Mercury and organic fluid thermometers must be certified prior to use and annually thereafter. Electronic thermometers must be certified prior to use and every six (6) months thereafter.

Table 2 lists the three ranges that must be used when certifying thermometers (all ranges are in degrees Celsius):

**Table 2**  
**Thermometer Certification Ranges**

Ambient temperature (water bath)	20 to 30
Cold temperature (ice bath)	-5 to 5
Hot temperature (heated water bath)	35 to 45

The transfer standard thermometer must agree within one ( $\pm 1.0$ ) degree Celsius of the NIST-traceable thermometer for all ranges. Thermometers used for meteorological purposes must agree within 0.2 degree Celsius. If not, the thermometer must be replaced or a correction factor must be applied.

## 10.0 Multimeters

Multimeters must be certified every six (6) months by performing a comparison with a NIST-traceable power supply. All ranges used must be certified. Normally this includes the 0 to 200 millivolt, 0 to 2 volt, and 0 to 20 volt ranges. Approximately ten evenly spaced readings are taken for each range. The transfer standard multimeter must agree with the NIST-traceable power supply within  $\pm 0.2\%$  of the full range being certified.

Table 3 lists the limits that must be met for the certification to be acceptable:

**Table 3**  
**Multimeter Certification Limits**

Range	Limit
0 - 200 millivolt	$\pm 0.4$ millivolts
0 - 2 volt	$\pm 0.004$ volts
0 - 20 volt	$\pm 0.04$ volts

Multimeters not meeting these limits may use a slope and intercept to meet the limits.

### **11.0 Relative Humidity**

Relative humidity transfer standards (e.g., hygrothermographs, hygrometers, and sling psychrometers) must be certified traceable to the OAQ/QAS Certification Facility's primary standard(s) every six (6) months. For hygrometer sensors, at least two (2) comparison points must be performed (e.g., one (1) indoors and one (1) outdoors). The transfer standard must agree within  $\pm$  six (6) percent relative humidity of the primary standard. If not, then a calibration must be performed. A sling psychrometer is certified by performing the certification on the two thermometers (see Section 8.0). The two thermometers must agree within  $\pm 1.0$  degree Celsius of the NIST-traceable thermometer unless they are being used for meteorological applications, then the limit is  $\pm 0.2$  degree Celsius. Relative humidity/dew point sensors used for meteorological audits must compare to the primary standard within  $\pm 0.7$  degree Celsius dew point.

### **12.0 BIOS and other Piston-Type Flow Systems**

BIOS and other piston-type flow systems must be verified annually by comparison to the State-QAS Primary Standard Cal Technix Flow System. Those units which agree within  $\pm 2.0\%$  of the primary standard will not require a slope and intercept correction. Units which do not meet the verification limit may use a slope and intercept correction; however, all points must fall within  $\pm 2.0\%$  of the least squares calibration line of best fit. In addition, only those systems which do not require a soap solution and use an NIST-traceable volume and time can be verified. All other systems will only be certified, which means a slope and intercept will be used. For calculation of the flows using a slope and intercept, see Equation 6-12.

### **13.0 Class "S" Weights**

Class S weights must be verified annually by comparing the transfer standard Class "S" weights with Type 1, Class 1, "S" weights. To be verified as Type 1, Class 2 weights, they must be verified annually and meet the tolerances listed in Table 4.

**Table 4**  
**Class 2 Metric Weight Tolerances**

<b>Denomination Metric</b>	<b>Tolerance Limits</b>
100g	0.50mg (.00005g)
50g	0.25mg (.000025g)
30g	0.15mg (.00015g)
20g	0.10mg (.00010g)
10g	0.074mg (.000074g)
5g	0.054mg (.000054g)
3g	0.054mg (.000054g)
2g	0.054mg (.000054g)
1g	0.054mg (.000054g)
500mg	0.025mg (.000025g)
300mg	0.025mg (.000025g)
200mg	0.025mg (.000025g)
100mg	0.025mg (.000025g)
50mg	0.014mg (.000014g)
30mg	0.014mg (.000014g)
20mg	0.014mg (.000014g)
10mg	0.014mg (.000014g)
5mg	0.014mg (.000014g)
3mg	0.014mg (.000014g)
2mg	0.014mg (.000014g)
1mg	0.014mg (.000014g)

## **14.0 Certification/Calibration/Verification of Miscellaneous Transfer Standards**

### **14.1 Introduction**

Certification/calibration/verification procedures are available from OAQ/QAS upon request, for the miscellaneous transfer standards listed below. The requirements for each type of transfer standard are summarized below in Table 5. All transfer standards must be certified/calibrated/verified to OAQ/QAS primary standards or be approved by OAQ/QAS.

#### **14.1.1 Elapsed Time Meters**

Elapsed time meters (ETM) must be certified every six (6) months by performing a comparison with an NIST-traceable stop watch. The transfer standard elapsed time meter must agree within two ( $\pm 2$ ) minutes of the stop watch over a 24-hour period.

The certified ETM can be used to certify/audit ETMs used for field measurements.

#### **14.1.2 Barometers**

Aneroid and electronic barometers must be certified traceable to the OAQ/QAS Certification Facility's mercury barometer at station pressure every six (6) months. The transfer standard barometer must agree within  $\pm 0.2\%$  (approximately 1.5 mmHg). If not, it must be recalibrated.

#### **14.1.3 Wind Speed Calibrators/Selectable Speed Anemometer Drives**

Wind speed transfer standards must be certified annually to the NIST-traceable OAQ/QAS Certification Facility's Photo Tachometer. Clockwise and counterclockwise measurements must be taken. The transfer standard must agree within one ( $\pm 1.0$ ) RPM of the Photo Tachometer. If not, the instrument must be taken out of service or a correction factor applied.

#### **14.1.4 Strip Chart Recorders**

Strip chart recorders must be calibrated annually using a NIST-traceable power supply.

#### **14.1.5 Pyranometer/Radiation Sensors**

Radiometers should be calibrated annually. Pyranometers and any other radiation measuring sensors must be calibrated once every two (2) years. Calibrations for these instruments will normally be performed by the manufacturer because the QAS Certification Facility does not have a radiation source.

#### **14.1.6 Power Supply**

Power supplies must be certified annually by comparing the transfer standard power supply with a NIST-traceable power supply.

#### **14.1.7 Stop Watches**

Stop watches must be certified against a NIST-traceable source annually. These certifications can be performed by the manufacturer, the agency, or the Quality Assurance Section.

#### **14.1.8 Rotameters**

Rotameters must be certified annually with a NIST-traceable flow device.

#### 14.1.9 Electronic Manometers

Electronic manometers must be certified annually according to the user's manual.

#### 14.1.10 Photo Tachometers

Photo tachometers must be calibrated annually according to the user's manual.

**Table 5**  
**Certification/Calibration/Verification of Miscellaneous Transfer Standards**

<b>Instrument</b>	<b>Frequency</b>	<b>Primary Standard</b>	<b>Limit</b>
Elapsed Time Meter	6 months	Stop Watch NIST Traceable	±2 minutes/24 hours
Barometer	6 months	Mercury Barometer	±0.2% of full scale
Wind Speed Calibrator and Selectable Speed Anemometer Drive	annually	Photo Tachometer	±1 RPM
Strip Chart Recorder	annually	Power Supply	Manufacturer's requirements
UV Radiation Sensor	annually	Manufacturer's radiation sensor	Manufacturer's requirements
Solar Radiation Sensor	2 years	Manufacturer's radiation sensor	Manufacturer's requirements
Power Supply	annually	Manufacturer's power supply NIST Traceable	Manufacturer's requirements
Stop Watch	annually	Atomic Clock	Manufacturer's requirements
Rotameter	annually	Flow device NIST Traceable	Manufacturer's requirements
Electronic Manometer	annually	Liquid Manometer	Manufacturer's requirements
Photo Tachometer	annually	Manufacturer's primary standard	Manufacturer's requirements

**Form 1**  
**Department of Environmental Management**  
**Office of Air Quality**  
**SO<sub>2</sub> Calibration with Permeation Tube**

Comments:

Site: QALab  
Analyzer Brand/Model: Dasobo 410B  
Analyzer S.N.: 766  
Date: 04/21/98  
Initials: KRG  
Zero Pot: 122  
Span Pot: 831  
Sample Flow: 600 CC  
Calibrator Brand/Model: TECO 146  
Calibrator SN: 146t-53568-297  
Prim. Std. Perm. Rate: 1.986  
Perm Tube SN: 93-077  
Perm Tube Installed: 02/26/98  
Calculated Slope: 1.00219  
Calculated Intercept: 0.00050  
Correlation Coefficient: 1.00000

Setting	Barom. Press.	Temp	Vapor Press.	Correction Factor	Volume	Total Time	Flow	Monitor Response (X)	Measured Conc.	Standard Conc. (Y)	% Diff
0.75	736.0	294.5	19.23	0.95433	100	6.40	0.8947	0.846	0.8484	0.8479	0.1%
1.75	736.0	295.0	19.82	0.95193	1000	31.03	1.8407	0.410	0.4114	0.4112	-0.2%
3.75	736.0	295.0	19.82	0.95193	1000	15.38	3.7136	0.203	0.2039	0.2043	-0.2%
7.75	736.0	294.5	19.23	0.95433	1000	7.66	7.4752	0.101	0.1017	0.1015	0.2%
Zero Air								0.000		0.0000	

\*\*\*\*% Difference points must be within 3%

\*\*\*\* % Difference range must be within 4%

**Form 2**  
**Department of Environmental Management**  
**Office of Air Quality**  
**Ozone Transfer Standard**  
**Certification**

**File Name**

28	30	19	03
----	----	----	----

Comments:

GEN=TB4.5, PHOTO=TB1.8  
FLOW=3.18 L/MIN

Settings:

1	2	3
.000	.400	.300
4	5	6
.200	.100	.080

X= Primary Standard    Y=Transfer Standard

Average ppm        X  
(Average - Zero)   X  
(Average - Zero)/O<sub>3</sub> loss

Average ppm        Y  
(Average - Zero)   Y

Agency: State QA

Parameter Being Certified: O<sub>3</sub>, Photometer

Transfer Standard Brand:        Dasibi

Initials:                                ADF

Ozone loss:                           0.987

Date:                                    05/28/98

Recertification Date: (6 weeks) 07/09/98

Transfer Standard Model:        1008-PC

Transfer Standard SN:            6144

New Transfer Standard Slope:   0.9944

New Transfer Standard Intercept: 0.000

Primary Standard        DASIBI 1008-RS SN 4199

1 (zero)        2            3            4            5  
6

0.0063	0.4005	0.2997	0.2030	0.1027	0.0826
0.0000	0.3942	0.2934	0.1967	0.0964	0.0763
0.0000	0.3994	0.2973	0.1993	0.0977	0.0773

0.0040	0.3995	0.3013	0.2009	0.1005	0.0799
0.0000	0.3995	0.2973	0.1969	0.0965	0.0759

	Slope	Intercept
Day 1	1.0030	0.001
Day 2	0.9972	0.000
Day 3	0.9914	0.000
Day 4	0.9882	0.000
Day 5	0.9928	0.000
Day 6	0.9940	0.000
Average	<b>0.9944</b>	<b>0.000</b>
Standard deviation	0.0051	0.000
Deviation %	0.5%	0.0%
1/average slope	<b>1.0056</b>	

For This Day:	
Slope:	0.9940
Intercept	0.000
Correl:	0.999968

Slope 6 must be within 5% of previous average:	-0.1%	OK
Deviation Slope must be 3.7% or less:	0.5%	OK
Deviation intercept must be 1.5% or less:	0.0%	OK
New Average Slope compared to previous average:	-0.1%	

**Form 3**  
**Department of Environmental Management**  
**Office of Air Quality**  
**Hi-Vol Orifice Calibration**

**Filename**

<b>28</b>	<b>50</b>	<b>30</b>	<b>04</b>
-----------	-----------	-----------	-----------

Agency: State QA  
Parameter Being Certified: Orifice, Regular  
System Brand: General Metal Works  
Initials: KRG  
Serial Number: QA#2  
Date: 03/06/98  
ReCalibration due by: 09/06/98  
Primary Standard: Roots Meter, SN 715707  
Site Temperature (K): 296  
Station Pressure (mmHg): 737  
Slope: 1.9190588  
Intercept: 0.0212978  
Previous Slope: NA  
Previous Intercept: NA  
Last Calibration: NA

Setting	Water	mmHg	Elapsed Time	Standard Flow (m <sup>3</sup> /min)	Curve Flow (m <sup>3</sup> /min)	% Diff.
100	8.20	37	113.87	1.465791	1.463277	-0.17%
90	7.10	34	123.37	1.358718	1.260826	0.16%
75	5.60	26	140.84	1.203724	1.1207316	0.30%
70	5.00	24	148.99	1.141079	1.140195	-0.08%
65	4.50	22	157.36	1.083416	1.081115	-0.21%

**Comments:      VALID**

**Formulas**

$Y = \text{Square Root} (\text{Water X (Ambient Pressure / 760)} \times (298 / \text{Ambient Temp.}))$

Volume Corrected to SRC = 3.0 cubic meters \* [(Amb. Press - mmHg) / 760] \* (298 / Amb. Temp.)

Stand. Flow = [(Volume Corrected to SRC / Elapsed Time) \* 60]

Curve Flow = (I / Slope) \* (Y - Intercept)

Percent Difference = [(Curve Flow - Standard Flow) / Standard Flow \* 100]

Flow Rates are at Standard Reference Conditions (298K Temp. and 760 mmHg)

Range Factor = [Manometer Reading \* Station Barometric Pressure (mmHg) / Site Temperature (K)]

**Limits:**

Percentage Difference must be within  $\pm 1.0\%$       0.3%

3 points from the curve must fall between 1.02 and 1.24      3

3 points from the curve must fall between 1.1 and 1.7      4

Average flows should be within  $\pm 2.0\%$  of the previous certification

Check at 1.13:      0.0%

Check at 1.30:      -0.7%

True Flow	Low	High
1.02	9.889	10.082
1.03	10.083	10.227
1.04	10.278	10.475
1.05	10.476	10.674
1.06	10.675	10.875
1.07	10.876	11.078
1.08	11.079	11.283
1.09	11.284	11.490
1.10	11.491	11.699
1.11	11.700	11.910
1.12	11.911	12.122
1.13	12.123	12.336
1.14	12.337	12.553
1.15	12.554	12.771
1.16	12.772	12.991
1.17	12.992	13.213
1.18	13.214	13.436
1.19	13.437	13.662
1.20	13.663	13.889
1.21	13.890	14.119
1.22	14.120	14.350
1.23	14.351	14.583
1.24	14.584	14.818
1.25	14.819	15.055
1.26	15.056	15.294
1.27	15.295	15.535
1.28	15.536	15.777
1.29	15.778	16.022
1.30	16.023	16.268
1.31	16.269	16.516
1.32	16.517	16.766
1.33	16.767	17.018
1.34	17.019	17.272
1.35	17.273	17.527
1.36	17.528	17.785
1.37	17.786	18.044
1.38	18.045	18.306
1.39	18.307	18.569
1.40	18.570	18.834